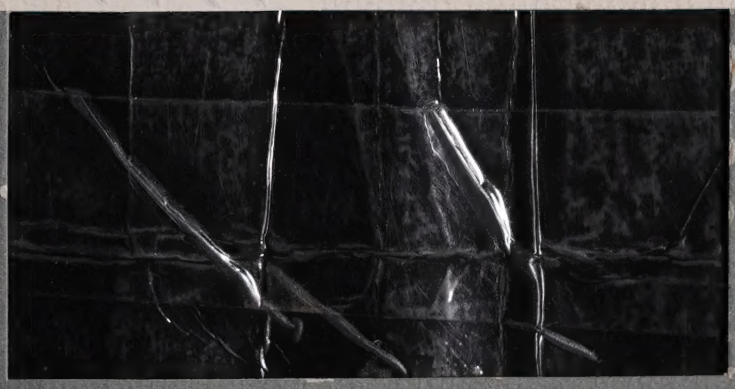
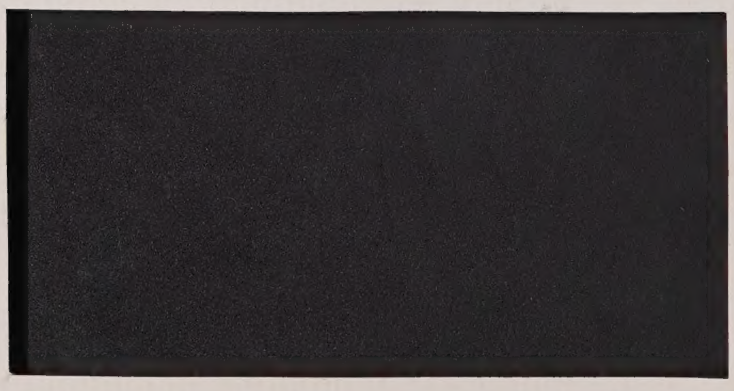
INV. # ~~38~~ 62



DEI

PRODUCERS OF NEMS CLARKE EQUIPMENT



NEMS CLARKE
EQUIPMENT

NOTE

The FSD-106G Demodulator is electrically and physically similar to the FSD-106A described herein. The appropriately tuned circuits have been adjusted for 10.000 mc instead of 10.035 mc. Therefore, all reference to 10.035 mc in the FSD-106A manual should be changed to read 10.000 mc.

INSTRUCTION MANUAL

MODEL FSD-106G
DEMODULATOR

29 September 1967

Defense Electronics, Inc.
PRODUCERS OF
DEI AND NEMS-CLARKE
EQUIPMENT

DEI
RESEARCH
DEVELOPMENT
MANUFACTURING

Rockville, Maryland 20854

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NEMS CLARKE EQUIPMENT

INSTRUCTION BOOKLET

13 March 1968

MODEL FSD-106G FOSTER-SEELEY DEMODULATOR

The Model FSD-106G Foster-Seeley Demodulator is a front panel plug-in module designed for use with NEMS-Clarke multi-range telemetry receivers. The FSD-106G contains a conventional Foster-Seeley fm demodulator and a bandpass filter which establishes the receiver's second i-f bandwidth. Physically locating the filter and the demodulator in the same mechanical package allows the performance of each demodulator to be optimized for the specific bandwidth.

Figure 1. FSD-100G Series Foster-Seeley Demodulator

The demodulator is mounted on a chassis constructed of heavy gauge aluminum, which provides shielding when the module is plugged into the receiver. The demodulator is approximately 2-1/8 inches wide, 4-1/8 inches high and 5-3/4 inches deep. The unit weighs approximately 1-1/2 pounds.

Defense Electronics, Inc.
PRODUCERS OF DEI AND NEMS-CLARKE EQUIPMENT
DEI RESEARCH DEVELOPMENT MANUFACTURING
Rockville, Maryland 20854

A list of performance specifications are listed below:

Filter:

Center Frequency	10.0[illegible] MHz.
Design Type	7 pole Butterworth LC.
Bandwidth	500 kHz, ±10%, at 3 dB points.
Shape Factor	(60/6 dB ratio) 2.8.

Demodulator:

Design Type	Foster-Seeley.
Linearity	2% maximum total harmonic distortion for peak deviation of 100 kHz at a modulating frequency of 1 kHz.
Output Level	3.0V p-p nominal peak deviation of 250 kHz.

INSTALLATION

The FSD-106AG demodulator is a complete subassembly plug-in module. All electrical connections are made automatically as the unit is inserted into the receiver main chassis. There are no cables to be manually connected during installation, or disconnected during removal.

To install the demodulator, insert it through the appropriate opening in the receiver front panel; once in place, tighten the knurled thumb screw.

To remove the demodulator, loosen the thumbscrew, then withdraw the unit from the receiver main chassis.

OPERATION

There are no operating controls incorporated into the FSD-106AG Consequently, there are no setup procedures.

The demodulator functions as an integral part of the receiver. Therefore the instruction manual for the receiver should be consulted for operation instructions.

PRINCIPLES OF OPERATION

The FSD-106A G comprises a Foster-Seeley Discriminator and an i-f bandwidth filter. The two subassemblies are discussed separately in the following paragraphs. The schematic diagram, figure 7, should be referenced during the discussions.

IF Bandwidth Filter

The filter network is composed of a seven pole Butterworth LC network with a center frequency input of 10.0 MHz, and an i-f bandwidth of 500 kHz. The filter with its sharp skirt selectivity determines the overall receiver bandwidth.

The output of the receiver's First IF Amplifier and Converter Module is connected to the filter through A2-P2. From A2-P2 the signal passes through a passive attenuator which properly terminates and matches the loss of the Butterworth filter. From the attenuator, the i-f signal is connected to the tapped inductance L1.

The tap is set to produce a 50 ohm input impedance to match the output impedance of the first IF amplifier and converter module. Inductor L1 is tuned with capacitor C1 and variable capacitor C35. Energy from the first resonant circuit or pole is capacitively coupled through C2 to the next resonant network. The coupling capacitances and the L to C ratio of seven resonant circuits vary to obtain the required maximally flat response. The output inductor L7 is tapped to produce a 50 ohm output impedance.

FM Demodulator

The output from the receiver's Wideband Limiter is connected to the fm demodulator through a coaxial cable to jack A3 of connector P2 and coupled capacitively to the base on input transistor Q1. Transformer T1 resonates the output capacitance of Q1, C23, and C24.

Diodes CR1 and CR2 are connected back to back and provide an additional stage of limiting. The signal to the base of transistor Q2 is divided down by capacitor C23 and C24 to prevent input capacitance variations from detuning the resonant circuit of T1. Transistor Q2 operates as an IF amplifier to drive the Foster-Seeley discriminator.

The collector circuit of Q2 is resonated by transformer T2 and C26. Energy is coupled to the secondary of transformer T3 by means of capacitors C29, C32, and variable capacitor C33. In this demodulator, all coupling is capacitive. This permits independent control of both the center frequency tuning and the bandwidth.

Transformers T2 and T3 convert the FM signal to an AM signal so it can be demodulated in a conventional AM manner by diodes CR3 and CR4. The resonant circuit of T3 and capacitor C31 is damped by resistor R11, R12 and R13, which

also form the dc path for the diode current. Capacitor C34 acts as a bypass capacitance for any IF signal present on the video side of the rectifying diodes. The output of the demodulator is made available at P2-10 for application to the Emitter Follower module in the receiver.

MAINTENANCE

WARRANTY NOTICE

Replacement of any components soldered to a printed circuit board by other than DEI factory representatives voids all warranties; in the event of a part/module failure requiring the use of a soldering iron on a printed circuit board, the equipment must be returned to the factory for replacement or repair to maintain the warranty.

CAUTION

If factory affixed seals are broken,
the warranty is voided.

The Model FSD-106A/G FM Demodulator is designed to give long and troublefree performance with a minimum of maintenance. During normal operation, no periodic adjustments are required; unnecessary adjustments should be avoided as they may degrade the performance of the unit. The FSD-106A/G should be kept clean, relatively dustfree, and in good mechanical condition. Lubrication is not required and should be avoided as damage to the unit could result.

Preventive Maintenance

The preventive maintenance for the FSD-106A/G consists of a monthly and an annual check which are given in the following paragraphs.

Monthly

The monly preventive maintenance check consists of blowing out the dust from the interior of the unit using low pressure air and making a visual inspection checking:

a. Resistors for blistering, discoloration, and other evidence of overheating.

b. Wiring for cut, cracked, or frayed insulation.

c. Machine screws and nuts for looseness.

d. Rear apron connectors for corrosion and loose connections.

e. Finish for scratches and bare spots.

Burned or discolored resistors, corroded plugs, and defective wiring should be replaced. When plugs or wiring have been replaced, refer to the schematic diagram in figure 7 to ensure that the proper connections have been made. Bare spots and scratches should be covered using any available touch-up paint.

Annual

The performance characteristics of the FSD-106A G, as an integral part of the receiver, should be checked annually. With the FSD-106A G demodulator installed in the receiver, check the overall performance of the receiver.

Corrective Maintenance

Corrective maintenance for the FSD-106A G consists of troubleshooting, replacement of defective component(s), and, if necessary, realignment of the unit.

Troubleshooting

Knowledge of the principles of operation as given in preceding paragraphs and familiarity with the schematic diagram shown in figure 7 are necessary prior to troubleshooting the FSD-106A G

The first check should be to ensure the fault is located in the demodulator. To do this, ensure the correct inputs are being applied to the demodulator.

Once the fault has been isolated to the demodulator, signal tracing methods can be employed to locate the defective stage or stages. After repairs have been made, the alignment of the particular circuit should be checked.

Repair and Replacement

All electrical parts employed in the FSD-106A G are considered non-repairable. A complete list of electrical parts is given herein. Component locations are shown in figures 2 and 3.

The demodulator subassembly comprises a pc card. The complete subassembly or individual components on the card may be replaced, as the situation demands. To replace the complete subassembly, disconnect the input and output cables, then remove the four screws holding the pc board in place.

Care should be exercised when replacing components on the pc board. The suggested procedure for removing components from the boards is given below; the procedure requires the following material and equipment.

Liquid soldering flux	1/8 inch, #18 AWG flat braid
Flux remover	Medium wattage soldering iron.

Apply a thin coat of liquid flux to the flat braid. Place and hold the braid over the solder joint. Apply heat to the braid, directly over the solder joint; the braid will absorb most of the solder.

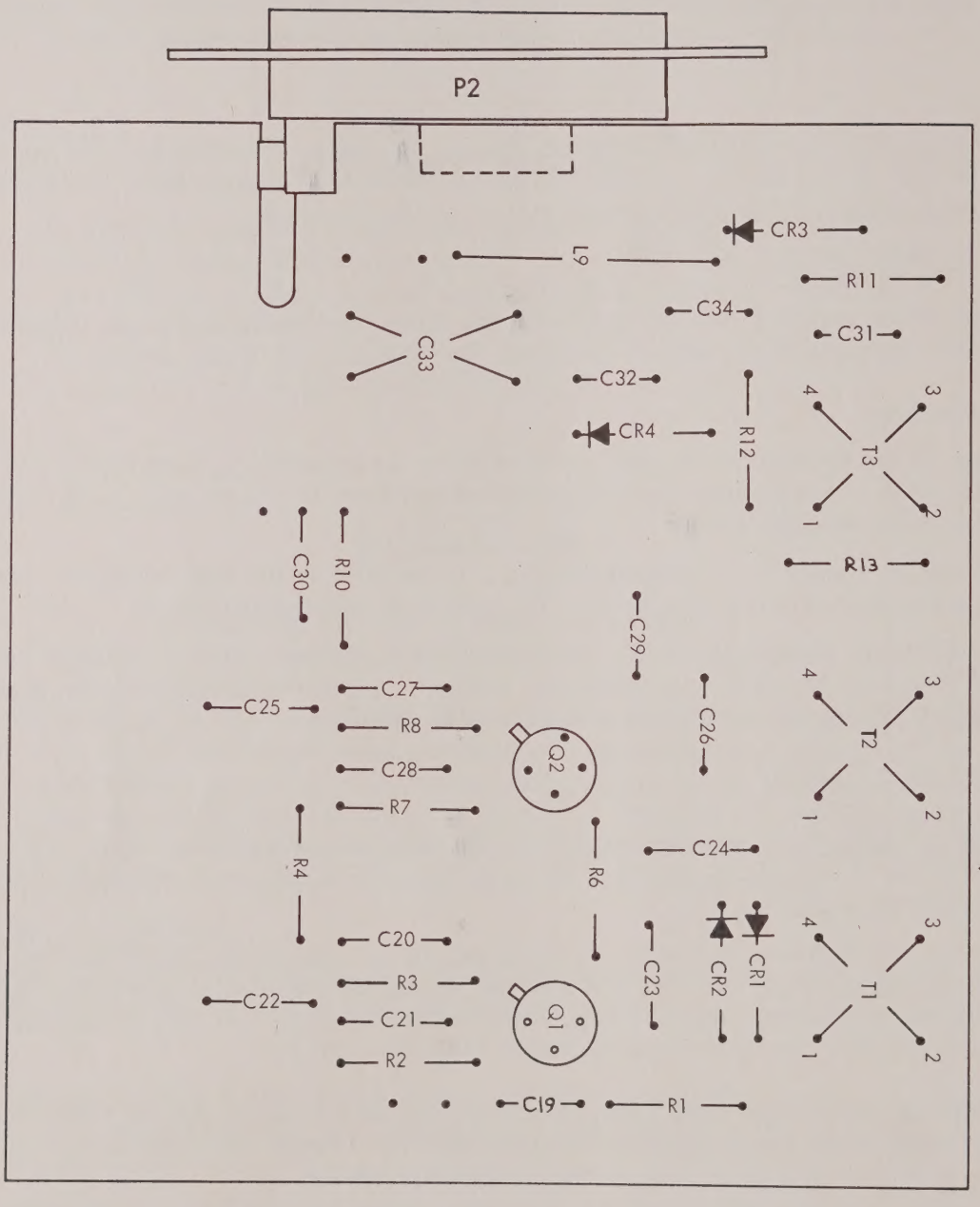


Figure 2. Demodulator, Component Location

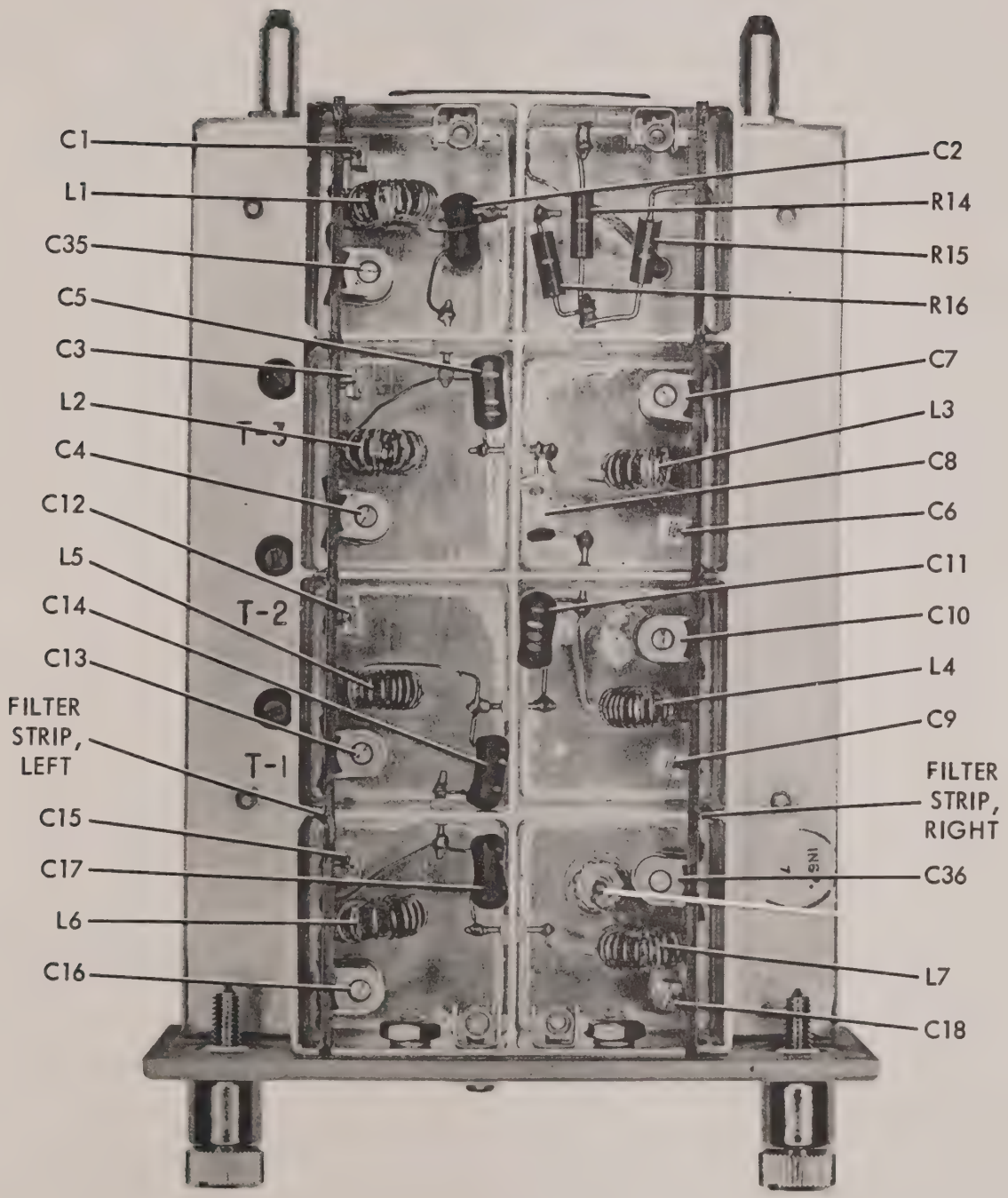


Figure 3. Bandwidth Filter, Component Location

CAUTION

Do not heat the joint for long periods of time as excess heat may damage the circuit board.

After the major portion of the solder has been absorbed by the braid, apply heat directly to the solder joint and pry the component loose. Clean the affected area using the flux remover. Trim the replacement component leads to the same length as the original component leads. Position the replacement component on the circuit board and solder it in place. Clean the affected area with flux remover.

ALIGNMENT

Recommended Equipment:

FM Generator	Boonton 202J
Univerter	Boonton 207G
Sweep Generator	Jerrold 602
Signal Generator	HP 606A
6 dB 50 ohm attenuator	
50 ohm coaxial RF Detector	
Oscilloscope	Tektronix 130C
Electronic Counter	HP 5245L
High Impedance Diode Probes	

IF Bandpass Filter

NOTE

The frequency of the signal generator being used for a marker, in this case the HP 606A Signal Generator, must be set precisely at 10.000 MHz utilizing the electronic counter.

a. Set up the test equipment as shown in figure 4 using short connecting cables wherever possible. The 50 ohm detector should remain connected to the output of the filter during the entire alignment.

b. Connect the high impedance diode probe to the top of inductor L1 (connecting leads must be as short as possible.)

c. Short circuit the top of L2 to ground, using a very short clip lead, at the feedthru terminal.

d. Adjust a 10.000 MHz marker input so that a mark can be seen on the oscilloscope. Adjust variable capacitor C35 for a maximum response at 10.000 MHz, as shown on figure 5, response No. 1 (during the alignment

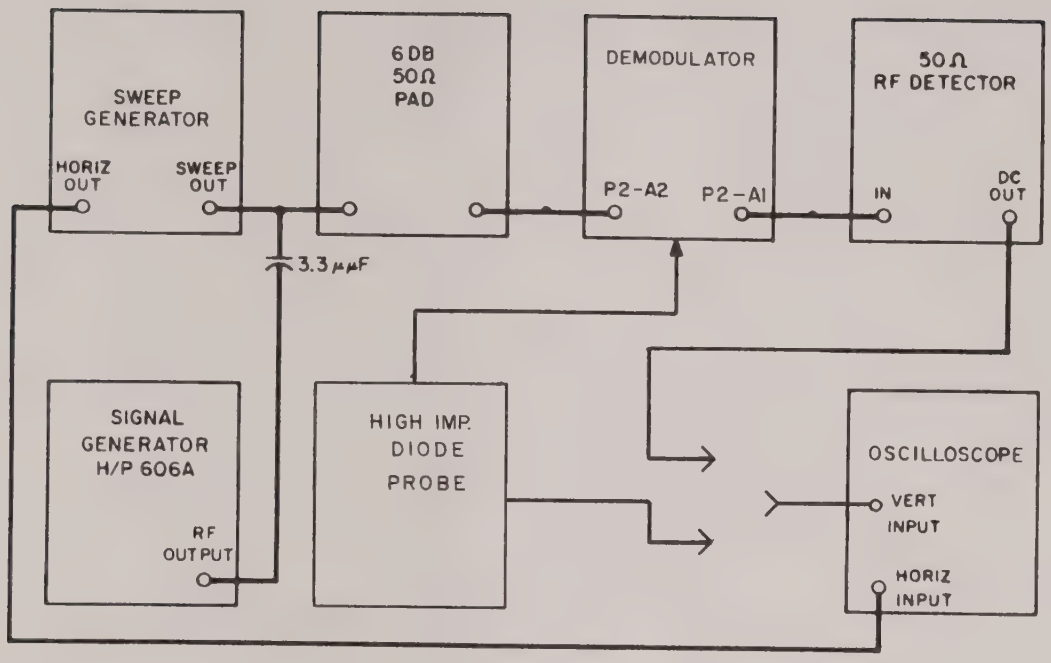


Figure 4. Alignment Procedure Test Set Up

procedure vary the amplitude and sweepwidth of the generator as necessary to provide the sharpest tuning.)

e. Remove the short circuit from L2 and short circuit the top of L3 to ground. Adjust C4 for a minimum response at 10.000 MHz as shown in figure 5, response No. 2, (the high impedance diode probe is left in the first stage during the entire alignment procedure.)

f. Remove the short circuit from L3 and short circuit L4. Adjust C7 for maximum response at 10.000 MHz, as shown in figure 5, response No. 3.

g. Remove the short circuit from L4 and short circuit L5. Adjust C10 for minimum response at 10.000 MHz, as shown in figure 5, response No. 4.

h. Remove the short circuit from L5 and short circuit L6. Adjust C13 for maximum response at 10.000 MHz, as shown in figure 6, response No. 1.

i. Remove the short circuit from L6 and short circuit L7. Adjust C16 for minimum response at 10.000 MHz, as shown in figure 6, response No. 2.

j. Remove the short circuit from L6 and adjust variable capacitor C36 for a maximum response at 10.000 MHz, as shown in figure 6, response No. 3.

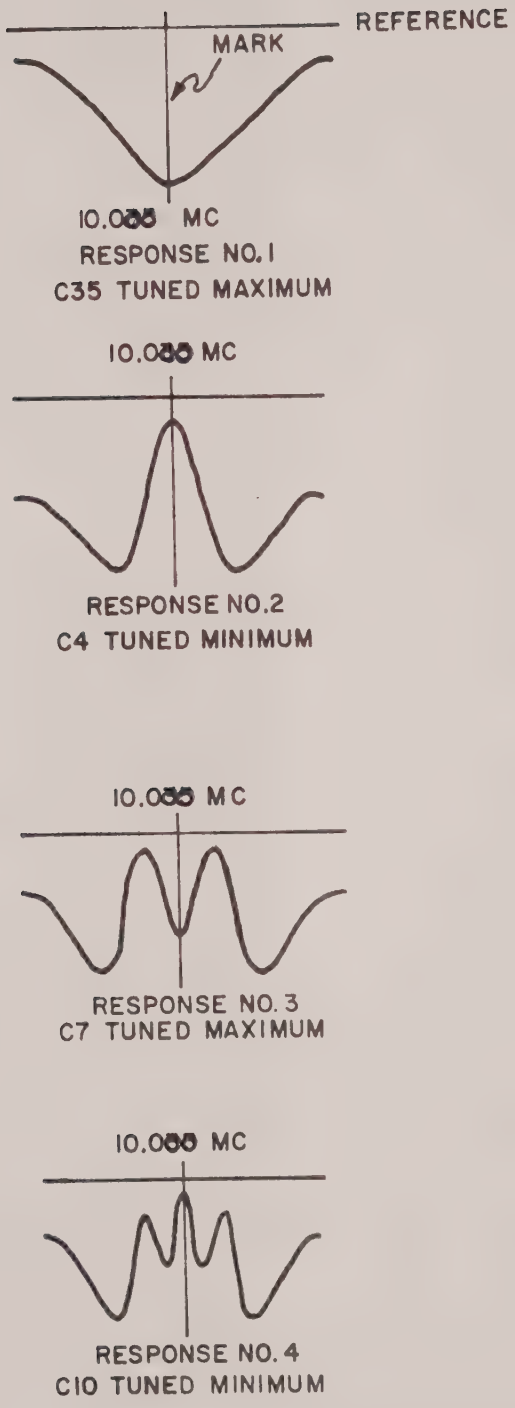
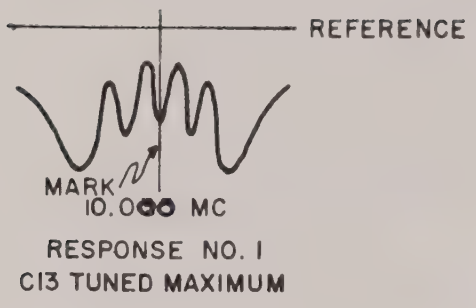
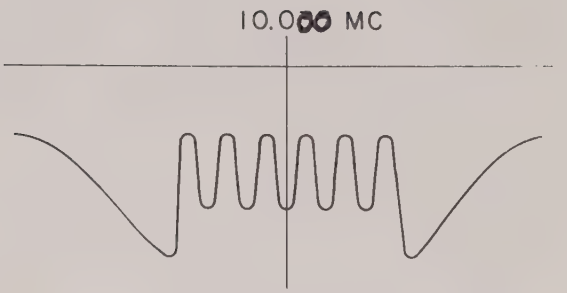


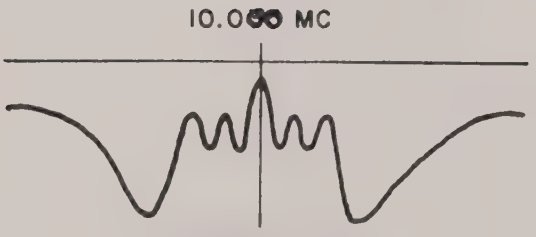
Figure 5. Oscilloscope Waveforms



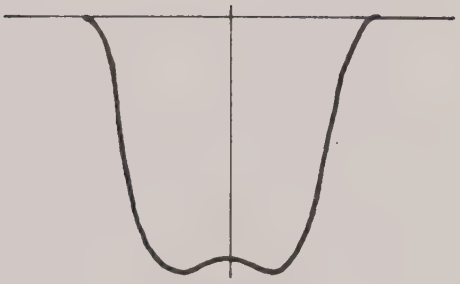
RESPONSE NO. 1
C13 TUNED MAXIMUM



RESPONSE NO. 3
C 36 TUNED MAXIMUM



RESPONSE NO. 2
C16 TUNED MINIMUM



RESPONSE NO. 4
OVERALL RESPONSE

Figure 6. Oscilloscope Waveforms

k. Remove the high impedance diode probe from the first stage and connect the oscilloscope to the 50 ohm detector to observe the overall filter response. (See figure 6, response no. 4). If the response is slightly unsymmetrical, a slight adjustment of tuning capacitor C35 and C36 should correct for this. If the overall response is very poor, the entire alignment procedure should be repeated being careful to adjust the maximum and minimum points precisely at 10.000 MHz.

Foster-Seeley Demodulator

a. Remove the demodulator plug-in from the receiver chassis and connect the module extension test cable from the demodulator to the receiver main chassis.

b. Connect the sweep generator to limiter module input J2.

c. Connect the oscilloscope horizontal amplifier to the sweep generator horizontal output and the oscilloscope vertical amplifier to emitter follower module input. This is on the base of Q1.

d. Adjust the sweep generator and the oscilloscope until a "S" curve appears on the oscilloscope trace. The generator should be near maximum output to ensure that limiter module is limiting.

e. Adjust T2, C33 and T3 for symmetrical "S" curve centered at 10.000 MHz utilizing the signal generator as a marker source.

f. T3 will control the center frequency of the "S" curve (zero crossover point), T2 will generally control the linearity and symmetry of the curve and C33 will control bandwidth and center frequency.

g. Reduce the sweep generator signal level output until the amplitude of the "S" curve has been reduced to half and adjust T1 for a maximum output on the oscilloscope. (When the amplitude has been reduced, the limiter module is no longer limiting).

h. Apply an FM modulated signal with a peak deviation of 250 kHz to the First IF Amplifier and second converter module jack J2. Set the frequency accurately to 30 MHz. (10.000 MHz at Predetect Output).

i. Then adjust the signal level until a pure signal output (no noise) appears on the oscilloscope connected to video output jack on the rear panel.

j. Adjust C33 if necessary, to obtain a reading of 50 ±30% on the Receiver Deviation Meter.

k. Adjust T3 for 0V dc at pin 10 of P2. With 10.065 MHz at Predetect Output. Adjust Tuning Meter Control R14 on the audio metering module if necessary to obtain zero reading on the tuning meter.

l. Reconnect the sweep generator in place of the signal at 30 MHz IF amplifier module, J2 and readjust T2 as required for the most linear "S" curve.

m. Repeat steps h through l inclusive.

ELECTRICAL PARTS LIST

FM DEMODULATOR, Reference figure 2

Reference Designation	Description
C1 through C18	Not assigned
C19 through C22	Capacitor, ceramic, 0.01 μF, +80-20%, 50V, Sprague 19C214
C23	Capacitor, mica, 82 pF ±5%, 500V, Elmenco DM15E820J03
C24	Capacitor, mica, 470 pF ±5%, 500V, Elmenco DM19E471J
C25	Capacitor, ceramic, 0.01 μF, +80-20%, 50V, Sprague 19C214
C26	Capacitor, mica, 75 pF ±5%, 500V, Elmenco DM15E750J03
C27	Capacitor, ceramic, 0.01 μF, +80-20%, 50V, Sprague 19C214
C28	Capacitor, ceramic, 0.01 μF, +80-20%, 50V, Sprague 19C214
C29	Capacitor, mica, 220 pF ±5%, 500V, Elmenco DM15F221J03
C30	Capacitor, ceramic, 0.01 μF, +80-20%, 50V, Sprague 19C214
C31	Capacitor, mica, 75 pF ±5%, 500V, Elmenco DM15E750J03
C32	Capacitor, mica, 39 pF ±5%, 500V, Elmenco DM15E390J03
C33	Capacitor, variable, 0.8 pF - 12 pF, 750V, JFD VC-31GW
C34	Capacitor, ceramic, 47 pF ±5%, 500V, R1CC27C0G470J5

FM Demodulator, continued

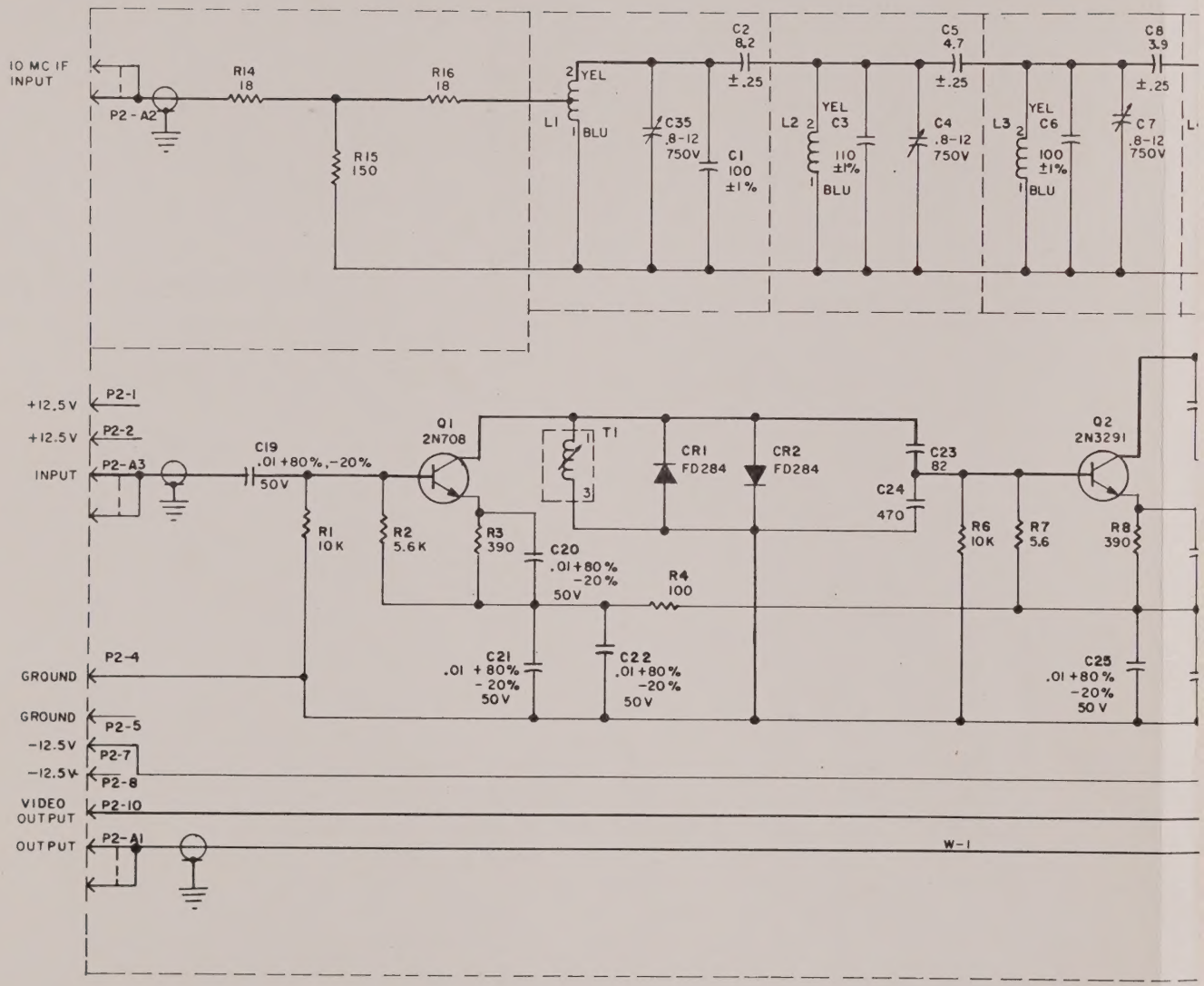
Reference Designation	Description
CR1 through CR4	Diode, Fairchild FD824 or 1N4305
L9	Inductor, fixed, 63 μH, Wilco 3063-15
P2	Connector, plug, Cannon DBM-13W3P, with 3 coaxial inserts, Cannon DM53740-5008
Q1	Transistor, 2N708
Q2	Transistor, 2N3291
R1	Resistor, composition, fixed, 10k μ5%, 1/2W, RC20GF103J
R2	Resistor, composition, fixed, 5.6k ±5%, 1/2W, RC20GF562J
R3	Resistor, composition, fixed, 390Ω ±5%, 1/2W, RC20GF391J
R4	Resistor, composition, fixed, 100Ω ±5%, 1/2W, RC20GF101J
R6	Resistor, composition, fixed, 10k ±5%, 1/2W, RC20GF103J
R7	Resistor, composition, fixed, 5.6k ±5%, 1/2W, RC20GF562J
R8	Resistor, composition, fixed, 390Ω ±5%, 1/2W, RC20GF391J
R9	Not assigned
R10	Resistor, composition, fixed, 100Ω ±5%, 1/2W, RC20GF101J
R11	Resistor, composition, fixed, 10k ±5%, 1/2W, RC20GF103J
R12	Resistor, composition, fixed, 4.7k ±5%, 1/2W, RC20GF472J
R13	Resistor, composition, fixed, 4.7k ±5%, 1/2W, RC20GF472J
T1	Transformer, NEMS-Clarke 101924-90
T2	Transformer, NEMS-Clarke 101924-90
T3	Transformer, NEMS-Clarke 101925-90

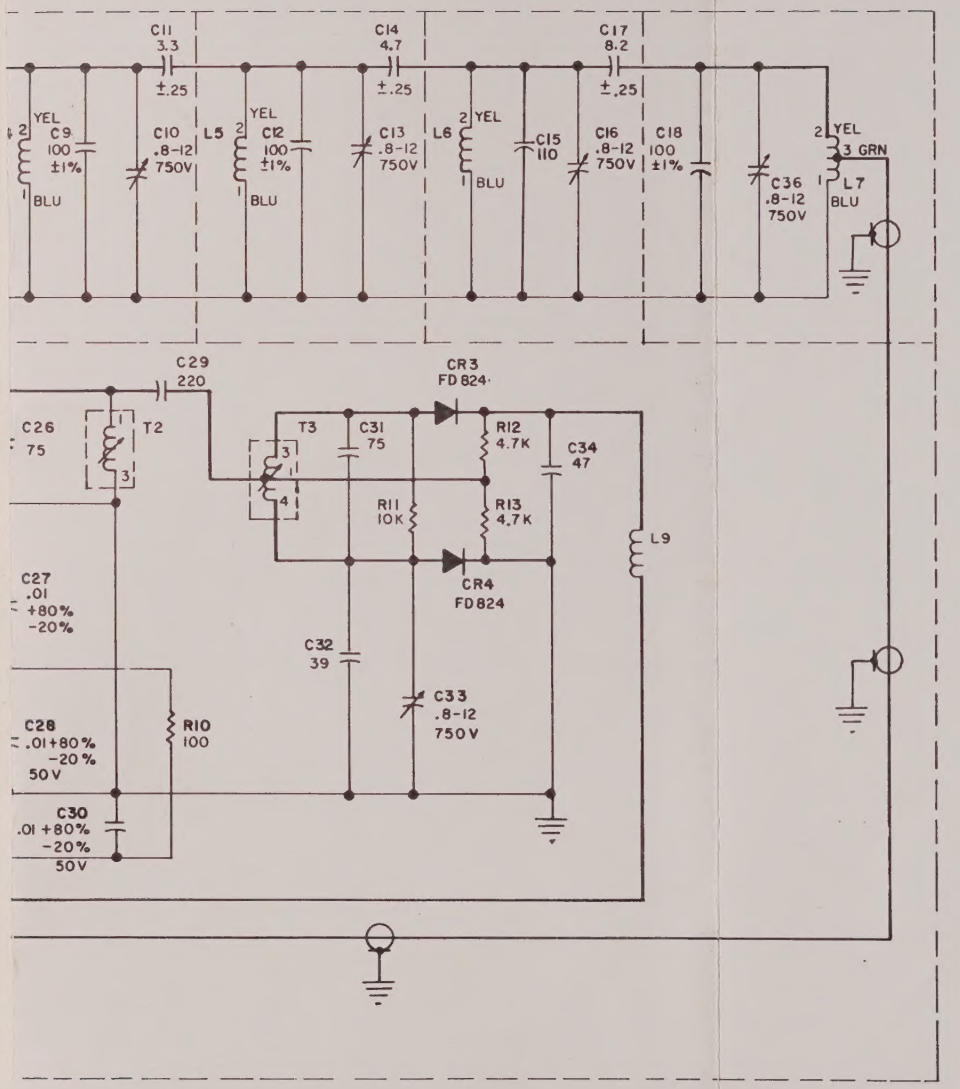
BANDPASS FILTER, Reference figure 3

Reference Designation	Description
C1	Capacitor, fixed, glass, 100 pF ±1%, 500V, CY10C101F
C2	Capacitor, fixed, ceramic, 8.2 pF ±0.25 pF, 500V, R1CC22C0H829C
C3	Capacitor, fixed, glass, 110 pF ±1%, 500V, CY10C11F
C4	Capacitor, variable, 0.8 pF - 12 pF, 750V, JFD VC-31GW
C5	Capacitor, fixed, ceramic, 4.7 pF ±0.25 pF, 500V, R1CC22C0H479C
C6	Capacitor, fixed, glass, 100 pF ±1%, 500V, CY10C101F
C7	Capacitor, variable, 0.8 pF- 12 pF, 750V, JFD VC-31GW
C8	Capacitor, fixed, ceramic, 3.9 pF ±0.25 pF, 500V, R1CC20H399C
C10	Capacitor, variable, 0.8 pF - 12 pF, 750V, JFD VC-31GW
C11	Capacitor, fixed, ceramic, 3.3 pF ±0.25 pF, 500V, R1CC22C0J339C
C12	Capacitor, fixed, glass, 100 pF ±1%, 500V, CY10C101F
C13	Capacitor, variable, 0.8 pF - 12 pF, 750V, JFD VC-31GW
C14	Capacitor, fixed, ceramic, 4.7 pF ±0.25 pF, 500V, R1CC22C0H479C
C15	Capacitor, fixed, glass, 110 pF ±1%, 500V, CY10C11F
C16	Capacitor, variable, 0 8 pF - 12 pF, 750V, JFD VC-31GW
C17	Capacitor, fixed, ceramic, 8.2 pF ±0.25 pF, 500V, R1CC22C0H829C
C18	Capacitor, fixed, glass, 100 pF ±1%, 500V, CY10C101F
C35	Capacitor, variable, 0.8 pF - 12 pF, 750V, JFD VC-31GW
C36	Capacitor, variable, 0.8 pF - 12 pF, 750V, JFD VC-31GW
L1	Inductor assembly, NEMS-Clarke 101721-93
L2	Inductor assembly, NEMS-Clarke 101721-91
L3	Inductor assembly, NEMS-Clarke 101721-94

Bandpass Filter, continued

Reference Designation	Description
L4	Inductor assembly, NEMS-Clarke 101721-94
L5	Inductor assembly, NEMS-Clarke 101721-94
L6	Inductor assembly, NEMS-Clarke 101721-91
L7	Inductor assembly, NEMS-Clarke 101721-93
R14	Resistor, composition, fixed, 18Ω ±5%, 1/2W, RC20GF180J
R15	Resistor, composition, fixed, 150Ω ±5%, 1/2W, RC20GF151J
R16	Resistor, composition, fixed, 18Ω ±5%, 1/2W, RC20GF180J


10 MC IF INPUT
P2-A2
R14 18
R16 18
R15 150
L1
2 YEL
1 BLU
C35 .8-12 750V
C1 100 ±1%
C2 8.2 ±.25
L2
YEL
C3 110 ±1%
BLU
C4 .8-12 750V
C5 4.7 ±.25
L3
YEL
C6 100 ±1%
BLU
C7 .8-12 750V
C8 3.9 ±.25
+12.5V P2-1
+12.5V P2-2
INPUT P2-A3
C19 .01 +80%,-20% 50V
Q1 2N708
T1
CR1 FD284
CR2 FD284
C23 82
C24 470
Q2 2N3291
R1 10K
R2 5.6K
R3 390
C20 .01+80% -20% 50V
R4 100
R6 10K
R7 5.6
R8 390
GROUND P2-4
C21 .01 +80% -20% 50V
C22 .01+80% -20% 50V
C25 .01 +80% -20% 50 V
GROUND P2-5
-12.5V P2-7
-12.5V P2-8
VIDEO OUTPUT P2-10
OUTPUT P2-A1
W-1



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   A. ALL RESISTANCES ARE IN OHMS, 1/2W, ± 5%
   B. ALL CAPACITANCES ARE IN MICROFARADS ± 5% (UNDER 1.0) 500V, OVER 1.0 ARE IN MMF, 500V
   C. ALL INDUCTANCES ARE IN MICROHENRIES

Figure 7. Model FSD-106A G Foster-Seeley Demodulator, Schematic Diagram

Defense Electronics, Inc.

Producers of DEI and NEMS-CLARKE Equipment

CAPABILITIES FOR — Aerospace, Industry, and Defense Hardware and Systems

RF EQUIPMENT

- VHF/UHF Transmitters
- VHF/UHF Telemetry Receivers
- Computer Controlled Receivers
- VHF/UHF Multicouplers
- VHF/UHF Preamplifiers
- Surveillance Receivers
- Predetection Up/Down Converters
- Video Distribution Amplifiers
- RF Spectrum Display Units
- Predetection and Post-Detection Diversity Combiners
- Two Channel and Three Channel Monopulse Tracking Receivers
- Conical Scan Tracking Receivers
- Instrumentation Wide Band FM Record/Reproduce Electronics
- Frequency Synthesizers

FM PRODUCTS

- Subcarrier Discriminators
- Voltage Controlled Oscillators
- Reference Oscillators
- Mixer-Amplifiers
- Analog-to-Digital Converters
- Subcarrier Translators
- Module Housings

DIGITAL EQUIPMENT

- PCM Decommutation Systems
- PCM Signal Conditioners/ Synchronizers
- Computer Input/Output Interface Equipment
- Digital Editing Systems
- Digital-to-Analog Converters
- Satellite Simulators

TEST EQUIPMENT

- Phase-Stable Calibration Signal Generators
- Collimation Transmitters
- Boresight Transmitters
- FM/FM Simulators (Data Insertion Converters)
- PCM Bit Synchronizer Error Analyzers

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- Analog Recording Systems
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- Monopulse Antenna Tracking Systems
- Conical Scan Antenna Tracking Systems
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- Communications Systems
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